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collected into book form they would certainly be still more serviceable. The inclusion of all known minerals would be a very desirable feature, but the more important ones should be marked by bold-face type.

The necessity for repetition of each species would be in a large measure obviated if a complete discussion of the rules governing the orientation of crystals in general were presented. Even in the tetragonal system two values of c must be given unless the student is first taught to distinguish first from second order pyramids, by relative size of faces, presence of cleavage, direction of striations, etc. And in the more complex systems similar rules can be formulated. In fact, if such rules had only been collected and presented in an authoritative way in some text-book long ago the rather unfortunate confusion in the present usage in orienting even some common crystals—as, for instance, making the long prism-like faces of gypsum the pyramid—might have been avoided.

Yes, by all means, the preparation of such a list of tables should be undertaken. And perhaps it would be worth while to include similar tabulations of some of the physical properties of minerals, such as color, hardness, etc., on a more elaborate scale than those in Dana's text-book, for instance.

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CHANGES OF BODILY FORM IN DESCENDANTS OF IMMIGRANTS

TO THE EDITOR OF SCIENCE: Four years ago Professor F. Boas, of Columbia University, was intrusted by the U. S. Immigration Commission with an investigation of the bodily characteristics of descendants of immigrants in America. The results of this undertaking were published two years ago in his report entitled "Changes in Bodily Form of Descendants of Immigrants" (Washington, 1910). In this report Dr. Boas questions the generally accepted theory of anthropologists that the form of the head is one of the most unchanging characteristics of human races,

and concludes that it is subject to "far-reaching" changes in type due to the transfer of the races of Europe to American soil.

Last year I wrote a critique of this report entitled "Professor Boas's New Theory of the Form of the Head—A Critical Contribution to School Anthropology,"¹ in which I took the ground that Professor Boas's own figures do not warrant his conclusion that the shape of the head is influenced by a new environment.

In a recent number of SCIENCE² there appeared a reply to my critique. As the general reader can not get a clear conception from this reply either of the nature of Boas's report of 1910 or of the salient points of my criticism of it, I venture to call attention to the following statements:

Professor Boas in his report of 1910 ignores all previous theories of this most complicated problem (see especially pp. 7, 31, 32, 51) and writes as follows:

Children born more than a few years after the arrival of the immigrant parent in America develop in such a way that they differ in type essentially from their foreign-born parents. These differences seem to develop during the earliest childhood and persist throughout life. It seems that every part of the body is influenced in this way; and even the form of the head, which has always been considered as one of the most permanent hereditary features, undergoes considerable changes. . . . The importance of this entirely unexpected result lies in the fact that even those characteristics which modern science has led us to consider as most stable are subject to thorough changes under new environment. (This is quoted in the "Introduction" to the Report.)

The head form, which has always been considered as one of the most stable and permanent characteristics of human races, undergoes far-reaching changes due to the transfer of the races of Europe to American soil (p. 7).

This fact is one of the most suggestive ones discovered in our investigation, because it shows that not even those characteristics of a race which have proved to be most permanent in their old home remain the same under our new surround-

¹Published in the *American Anthropologist*, XIII., 1911, 394-436.

²April 5, 1912, 537-40.

ings; and we are compelled to conclude that when these features of the body change, the whole bodily and mental make-up of the immigrants may change (p. 8).

The influence of American environment upon the descendants of immigrants increases with the time that the immigrants have lived in this country before the birth of their children (p. 9).

The influence of American environment makes itself felt with increasing intensity, according to the time elapsed between the arrival of the mother and the birth of the child (p. 17).

The type of the immigrants changes from year to year, owing to a selection which is dependent upon the economic conditions of our country. This is shown by the fact that after the panic of 1893 a sudden decrease in the general development of immigrants may be observed, which persisted for several years. A similar change seems to have taken place after the panic of 1907. (Here Boas gives his Table VIII. and Fig. 17, which includes stature, length of head, width of head, cephalic index, and width of face—showing the “general deterioration” in the type of immigrants after the panic of 1893; pp. 28–29.)

That there are not only decided changes in the rate of development of immigrants, but there is also a far-reaching change in the type—a change which can not be ascribed to selection or mixture, but which can only be explained as due directly to the influence of environment. This conclusion has been tested, and in many different ways, and seems to be amply proved. It has been stated before that, according to all our experiences, the bodily traits which have been observed undergo a change under American environment belong to those characteristics of the human body which are considered the most stable (p. 32).

A feature that is particularly noticeable is the general drop of all the absolute measurements after the year 1894. An attempt to combine all the material, adult and children, for these years, brings out the sudden drop after 1893 even more clearly, and a similar phenomenon is repeated between the years 1907 and 1909. For this reason I am inclined to believe that the type of immigrants is directly affected by financial panics (p. 39).

It would seem that the effect of American environment takes place almost immediately after the arrival of the parents (p. 43).

I think, therefore, that we are justified in the conclusion that the removal of the east European

Hebrew to America is accompanied by a marked change in type, which does not affect the young child born abroad and growing up in American environment, but which makes itself felt among the children born in America, even a short time after the arrival of the parents in this country. The change of type seems to be very rapid, but the changes continue to increase; so that the descendants of immigrants born a long time after the arrival of the parents in this country differ more from their parents than do those born a short time after arrival of the parents in the United States (p. 52).

In addition to that I may cite also Boas's explanation of his Fig. 17.

The most striking feature of the diagram is the general decrease in all measurements (viz., stature, length of head, width of head, cephalic index, width of face) in the period following the year 1894, which indicates that the arrivals during the period following the panic of 1893 were underdeveloped in every direction. The increase in the cephalic index during the same period does not contradict the data contained in the other curves (i. e., curves for stature, length and width of head, and width of face), because the index is not an absolute measurement, but the ratio between length of head and width of head. A preliminary tabulation of the measurements after 1907 shows a similar decrease to the one noted here. This decrease is perhaps due to the panic of 1907 (p. 29).

I ventured to characterize this theory as “*environmental-economic*”; and then pointed out that it is untenable, because of many biological and methodological inaccuracies. Not desiring to repeat my former discussion here, I refer the reader to my critique in the *American Anthropologist*.³

In this connection I may call attention to a criticism of the same report by the well-known Italian anthropologist, Professor G. Sergi, of the University of Rome, entitled, “The Pretended Change in the Physical Forms of the Descendants of Immigrants in America” (reprint from the *Rivista Italiana di Sociologia*, Jan.-Feb., 1912). He says:

The numerical series, the diagrams, the claims, the seriousness of the New York anthropologist (Boas) lend credit to the conclusions above men-

³ Op. cit., 1911, pp. 394–436.

tioned (viz., Boas's conclusions), to the great surprise of many anthropologists, some of whom have expressed their incredulity. Not having seen any criticism of Boas, but sounds of retraction on the part of Boas himself, I wish to show how the method which he followed is inexact, and why we can place no faith in his surprising conclusions (p. 4).

Professor Sergi confines himself to the cephalic index, but he rightly says that what is true of the form of the head is equally true of the other data. He continues:

If we consider the other physical forms of the descendants of immigrants, our conclusion acquires a wider and more general significance, viz., that no change of human physical characteristics through the influence of environment has been proved. If, as a matter of fact, there is no change in the physical forms of immigrants in America, the process according to which this change must have theoretically come about is an absurd one (p. 10).

The main points of my criticism of Professor Boas's report of 1910 refer not to classification of the cephalic index, but to the *causes* of its changes. The conventional classification of head forms may or may not be irrelevant. My critique did not treat this problem at all; it only recalled to Professor Boas the fact that he uses familiar technical terms such as "type," "longheaded," "short-headed," which everybody knows but which do not agree with his figures or tables. He says:

The east European Hebrew who has a very round head, becomes more long-headed; the south Italian, who in Italy has an exceedingly long head, becomes more short-headed (p. 7); that the long-headed foreign-born Italians become more short-headed in America (p. 51).

In regard to the cephalic index Professor Sergi, after presenting a table on page 7 of his critique, says:

If we examine the averages (media) of the cephalic index, we doubtless find that for those born in America there is a diminution of from one to two units (or a little more) as compared with those born outside of America. It is this which Boas has shown in his numerous tables. But does this diminution in the averages show, as

Boas pretends, a change in the form of the skull of Jews born in America? Apparently, yes, but in reality, no; because the averages are simply the rude expressions of the composition of the series (p. 7).

That Professor Boas's many sweeping conclusions on the form of the head are based on averages only is shown throughout his report (see especially, pp. 8, 43, 9, 12). Dr. Sergi is right in saying:

The series vary in their composition as might be expected and the averages do not give the character of the composition. In fact these would seem to indicate that certain groups are more and others less brachycephalic while the truth is, that some groups contain more brachycephalics (p. 6).

On p. 8 Professor Sergi gives a comparison and concludes that the real result of it is that only the proportions of the classes are altered; and therefore while they exist in different proportions, there still exist dolichocephalics, mesocephalics, brachycephalics and hyperbrachycephalics among those born in America. Therefore this difference of proportion of the classes can not be said to depend on the change of the form of the skull, but upon the paternal and maternal ancestry, the Jews being immigrants from every part of Europe. Boas does not say from which group his subjects come. In other words, they are the children of every European nationality to which the Jews belong (p. 8).

On p. 10 Dr. Sergi says:

But Boas would have us also believe that the children of immigrants who live in America ten years or longer undergo a more distinct and pronounced change, while the parents undergo none whatever. We should then have to suppose that a general change must have been going on in the organism of the immigrants which modified their generative cells, the ova and the spermatozoa, so that in the embryonal and later development the organism of the children appears modified in form. Who can support such a theory? It appears even more absurd inasmuch as it operates in two directions opposed to each other, the brachycephalics seemingly tending toward dolichocephaly (*i. e.*, with the Jews), and the dolichocephalics tending toward brachycephaly (the case of the Sicilians), by virtue—says Boas—of the environment. The change in the generative cells of immigrants would have to follow in two opposite directions, being most rapid (according to Boas) in the immigrants

of any year and a little less rapid in those of ten. . . . Admitting the theory of the inheritance of acquired characteristics as proven, a change would have to appear in the parents after a long stay in the United States, and this change would have to be transmitted to the descendants; i. e., the cephalic, facial and other forms would first change in the parents and would then be transmitted to the children. But this is not the case; according to Boas such a change appears *ex novo* in the children as soon as the parents land in America or have lived here a year or two. This is absurd in theory and as a matter of fact these are not the conditions, as I have shown.

Finally, Dr. Sergi says that one is tempted to ask:

Why should the two types tend toward a common form in America? Is it because one finds there one fixed type, either absolutely dolichocephalic or decidedly brachycephalic? Not even such a justification exists, because America, both with regard to her natives and her immigrants, has always had dolichocephalics, mesocephalics and brachycephalics; hence there is no influence of environment which can tend to fix a single cephalic form in either natives or immigrants (p. 11).

The general reader ought to know these facts. The main purpose of my critique, as well as that of the present discussion, is not to answer but to raise the questions in regard to the causes of changes of the cephalic type. Whatever the *prima facie* explanation may be, the causes of the shape of the head can not be solved by Boas's new theory, because it is, as I showed in my critique, "based rather on a cross-section of the facts than on a genetic interpretation of them. It is only a genetic description and explanation of them that can give a trustworthy basis for a theory." Is it not a fact that in a considerable part of present-day anthropological, psychological and pedagogical writings one is led to think that the most primary phenomena have been examined with mathematical accuracy, when as a matter-of-fact there must have been left out of account numerous accompanying conditions which determined, to a greater or less extent, the results of the problem studied.

The main objection to Professor Boas's new theory of the changes in bodily form of

descendants of immigrants in America is that it finds only one causal relation, viz., that between figures and environment, ignoring all biological and methodological factors. He does that in spite of the most recent attempts of biologists to explain all organic and inorganic changes by the principles of "plural effects" and "the limits of possible oscillations" (see especially Petrunkevitch's "Gedanken über Vererbung," Freiburg, 1904). These modern biologists support their theories also by the logic of mathematics; so, for example, the formula comprising the ellipse, the parabola and the hyperbola (where r and Δ are polar coordinates):

$$r = \frac{ep}{1 - e \cos \Delta}$$

is capable of many solutions and thus creates many possibilities. I believe that Professor Sergi is perfectly warranted in characterizing as "absurd" an anthropological theory which claims that human bodily forms are plastic and can be moulded even during the "first generation" and "a short time after the arrival of parents under new surroundings."

To sum up. As the general reader knows, the form of the head is considered by anthropologists as the most unchanging physical characteristic of the human body, so that the scientists classify the race into a few cephalic types. Professor Boas, on the contrary, makes unwarranted, sweeping conclusions that even the shape of the head undergoes far-reaching changes in type due to the new environment, a new theory which is not justified by his own figures and is not based on scientific methods and on the required technique of experimental physical anthropology.

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SCIENTIFIC BOOKS

Pflanzenphysiologie. By W. PALLADIN. Berlin, Julius Springer. 1911. Pp. vi + 310, figs. in text 180. Price M. 9, paper M. 8.

The new plant physiology from the hand of